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In the November number will appear:

Development of flower and embryo-sac in Aster and Solidago, by G. W. MARTIN, *Teacher of Biology, Indianapolis High School.*

A study of some anatomical characters of North American Gramineæ, by THEO. HOLM, *Department of Agriculture, Washington, D. C.*

Some new North American plants, by JOHN M. COULTER and E. M. FISHER, *University of Indiana.*

A probable new category of carnivorous plants, by CONWAY MACMILLAN, *Professor of Botany, University of Minnesota.*

The systematic position of Entosthodon Bolanderi, by JOHN M. HOLZINGER, *Department of Agriculture, Washington, D. C.*

BOTANICAL GAZETTE

OCTOBER, 1892.

A preliminary comparison of the hepatic flora of boreal and sub-boreal regions.[1]

LUCIEN M. UNDERWOOD.

The distribution of the hepatics of boreal and sub-boreal regions is becoming sufficiently understood to form some sort of a basis for comparative study, and while we yet have much to learn even of the best studied region of northern Europe, and still more from the higher latitudes of America and Asia, we can even now profitably gather some statistics and make some comparisons.

While it has long been known that the bryologic flora of the northern portions of both hemispheres was similar, so far as we know no exact comparisons have been instituted, on the hepatic side at least, to determine the nature and extent of this similarity. In the north temperate and arctic zones there are known about 575 species of Hepaticæ. Of these 375 belong to the flora of Europe, 300 to that of America, and perhaps 150 to that of Asia. Of these we may take as representing the boreal and sub-boreal portions, 173 species for northern Europe, 163 for northern America, and ninety-eight species for northern Asia. This will include in Europe, Scotland, North Germany, Scandinavia, and northern Russia, with the islands of Iceland and Spitzbergen; some of the species also extend to the higher Carpathians, the Alps and the Pyrenees; for America the colder regions from Newfoundland and Labrador to British Columbia and Alaska, including Greenland (whence some sixty species are known); and extending southward along the higher Appalachians as far as the Carolinas, and probably southward along the present *incognita* of the Rockies and the Sierras; for Asia it includes only the coastline of northern Siberia[2], for of the interior of Siberia, Turk-

[1] Read before Section F, A. A. A. S., Rochester meeting, August, 1892.

[2] Our knowledge of the north Asiatic flora is summarized in the following:—Lindberg and Arnell: Musci Asiæ Borealis. Kongl. Svenska Vet. Akad. Handl. No. 5 (1889). Mitten: An enumeration of all the species of Musci and Hepaticæ recorded from Japan. Trans. Linn. Soc. 2nd Ser. III. 153-206 (1891).

estan, the most of the Mongolian empire, and Thibet to the north slopes of the Himalayas, our knowledge of the hepatic flora is almost an absolute blank.

For our knowledge of the hepatic flora of boreal America we are indebted largely to the collections of two men, John Macoun, who has collected hepatics since 1866 from Nova Scotia to Little Slave Lake and the confines of Alaska, and Rev. Arthur E. Waghorne, who has collected in recent years in Newfoundland and Labrador. From these two collectors alone we have examined over a thousand packets of hepatics during the past three years. In addition we have the results of the labors of Mr. Pearson[1] on Macoun's earlier collections, and the still earlier collections of Drummond, which were worked up by Taylor whose collection at Cambridge furnishes considerable material bearing on the northern species. The Greenland flora has been summarized by the Danish botanists[2], and several collectors (Krause brothers, J. M. Macoun, Miss Cooley, and others) have taken scattering species in Alaska. The bryology of that region, however, demands much more thorough exploration than has hitherto been given it.

The difficulties arising in the systematic study of these northern collections are fourfold:—

1. The similarity of the American to the European flora, rendering necessary a thorough familiarity with all the European species, varieties and forms.

2. The undue refinement of specific distinctions made by recent European hepaticologists especially in the genera Scapania, Cephalozia, Marsupella, Nardia and Jungermania.

3. The confusion introduced by periodic upheavals of nomenclature, notably by Lindberg among the Scandinavian species, which very largely interlace with those of America.

4. Absence of many types and inaccessibility of most that are in existence; combined with this are the conflicting opinions of European authorities regarding the autonomy and identity of many species, and the misleading character of many European exsiccatae.

In spite of these difficulties, we are gradually getting order out of chaos, and hope in time to have the American forms satisfactorily co-ordinated with the European.

[1] List of Canadian Hepaticæ, 1890.

[2] Lange: Hepaticæ in Meddelelser om Gronland, Tredie Hefte, pp. 407-421 (1887).

As most of this paper is necessarily statistical, we present only some of the leading features of a detailed study of the three floras:—

1. Of the 214 boreal and sub-boreal species, eighty per cent. are European, seventy-six per cent. are American, and forty-six per cent. are Asiatic. While the larger part of the species of Europe and America have been brought to light, it is quite likely that the smaller number known from the more extensive Asiatic continent is due to the limited exploration of that region.

The distribution by orders can be seen as follows:—

	Species common to Europe, America, Asia.	Species common to Europe and America.	Species common to Europe and Asia.	Species common to America and Asia.	Exclusively European.	Exclusively American.	Exclusively Asiatic.
Ricciaceæ,	4	6	5	4	1	1	–
Marchantiaceæ,	7	9	10	7	1	1	–
Anthocerotaceæ,	–	2	–	–	–	–	–
Jungermaniaceæ,	56	112	70	58	24	32	10
Totals	67	129	85	69	26	34	10

Further percentages will appear in the following:—

	Number.	Per cent. of all boreal species.
Circumpolar species	67	31
Species common to Europe and America	119	60
Species common to Europe and Asia	85	39
Species common to Asia and America	69	32
Endemic species of Europe	26	12
" " of America	32	15
" " of Asia	10	4

2. Of the 163 American species, 129 or seventy-eight per cent. are of the European flora; sixty-nine are also Asiatic, while thirty-two or twenty per cent. are endemic.

3. Of the ninety-eight Asiatic species, eighty-five (or eighty-six per cent.) are European, while only ten (ten per cent.) are endemic.

4. Of the 173 European species only twenty-six, or fifteen per cent. are endemic, and this number is likely to be reduced by further exploration of the Asiatic and American floras.

5. 67 species encircle the pole being found in America, Europe and Asia. The percentage of these circumpolar species varies among the orders; while only 30 per cent. of the

boreal and sub-boreal Jungermaniaceae are circumpolar, there is a rise to 44 per cent. in the Ricciaceae, and to 50 per cent. in the Marchantiaceae. No species of Anthoceros are yet reported from Asia, although two species are common in northern Europe and America.

6. As might be expected certain northern hemisphere genera predominate. The genera Jungermania, Scapania, Marsupella and Cephalozia form 41 per cent. of the Hepaticae of all Europe, while the same genera of the northern portions form 46 per cent. of the species. For America the corresponding per cents are twenty-five and thirty-seven. Forty-seven per cent. of the flora of northern Asia is made up of the three genera, Jungermania, Cephalozia and Scapania, the genus Marsupella being strangely absent from that flora. Some comparisons of the larger genera will show more clearly the tendency of certain genera to increase relatively northward:—

	EUROPE.		AMERICA.	
Genera.	Per cent of all species.	Per cent of boreal spec.	Per cent of all species.	Per cent of boreal spec.
Riccia,	6.9	4	6.6	3.7
Aneura,	1.8	4	2	3
Cephalozia,	7	10	4.3	8
Frullania,	1.8	1.7	7	5.5
Jungermania,	19	22	14	19
Lejeunea,	3.7	1.1	7.6	1.9
Marsupella,	7.7	7	1.6	2.4
Nardia,	3.2	2.3	2.6	3
Radula,	3	0.6	3.6	1.8
Scapania,	6.9	6.3	4.3	7.3

While the above table shows the relative increase of such northern genera as Aneura, Cephalozia, Jungermania, Marsupella and Scapania, it also shows the relative decrease of such warm temperate and tropical genera as Riccia, Frullania, Lejeunea and Radula. It also shows the excessive development of Frullania and Lejeunea in America, and that of Cephalozia, Marsupella and Jungermania in Europe.

7. The ninety-eight north Asiatic species are distributed among thirty-seven genera, nineteen of which are monotypic; of these all but three are also American; Peltolepis and Prasanthus are found in Europe but not in America, while Calycularia alone is endemic.

8. Of the boreal species of Europe two genera only are not represented in either America or Asia.[1] These are

[1] Of the European genera of lower latitudes Corsinia, Riella, Tessellina, Acrobolbus, Adelanthus, Calypogea, Gymnoscyphus and Petalophyllum have not been found in America.

Pleurozia and Scalia. All the genera of boreal Ameria are European.[1]

9. The following genera common to Europe and America have not yet appeared in the N. Asiatic flora: Aitonia, Anthoceros, Fossombronia, Herberta, Hygrobiella, Jubula, Liochlaena, Marsupella, Pallavicinia and Pleuroclada.[2]

10. The following comparisons of some of the larger genera are further illustrative:

	EUROPE.			AMERICA.			ASIA.		COMMON TO			
	Total species.	Boreal species.	Endemic.	Total species.	Boreal species.	Endemic.	Total species.	Endemic.	Europe, Asia, America.	Europe, Amer.	Europe, Asia.	Asia, America.
Riccia	26	7	15	20	6	9	5	–	4	10	5	4
Fimbriaria	7	2	4	7	2	4	2	–	2	3	2	2
Anthoceros	5	2	2	12	2	9	–	–	–	3	–	–
Aneura	7	7	2	6	5	1	3	–	3	5	3	3
Cephalozia	27	18	14	13	13	3	9	–	5	9	8	6
Frullania	7	3	4	21	9	18	2	–	1	3	1	1
Jungermania	73	38	41	43	31	17	29	4	19	26	25	19
Lejeunea	14	2	9	23	3	18	–	–	–	5	–	–
Marsupella	29	12	25	5	4	1	–	–	–	4	–	–
Nardia	12	4	7	8	5	4	1	–	–	4	1	–
Plagiochila	7	3	0	7	4	0	2	–	1	3	1	2
Porella	7	4	1	11	6	6	2	1	1	6	1	1
Radula	10	1	9	11	3	10	1	–	1	1	1	1
Scapania	26	11	16	13	12	5	8	–	6	8	8	6

11. The following species are circumpolar, inhabiting America, Asia and Europe.

Riccia bifurca.
crystallina.
fluitans.
glauca.
Asterella hemisphaerica.
Conocephalus conicus.
Fimbriaria fragrans.
pilosa.
Grimaldia fragrans.
(*G. barbifrons.*)
Marchantia polymorpha.
Preissia hemisphaerica.
Aneura latifrons.
palmata.
pinguis.
Anthelia Juratzkana.
Arnellia Fennica.
Bazzania trilobata.
Blasia pusilla.
Blepharostoma trichophyllum.
Cephalozia bicuspidata.
catenulata.
fluitans.
multiflora.
pleniceps.
Chiloscyphus polyanthos.
Diplophyllum taxifolium.
Frullania dilatata.
Geocalyx graveolens.
Gymnomitrium coralloides.

[1] Of American genera of lower latitudes Cryptomitrium and Thallocarpus only are endemic.

[2] Together with Sphaerocarpus, Dumortiera, Lunularia, Targionia and Notothylas from lower latitudes.

Harpanthus Flotovianus.
Jungermania alpestris.
attenuata.
autumnalis.
barbata.
bicrenata.
excisa.
exsecta.
Floerkii.
incisa.
inflata
Kunzeana.
lycopodioides.
minuta.
porphyroleuca.
pumila.
quinquedentata.
saxicola.
sphaerocarpa.
ventricosa.
Kantia trichomanis.
Lepidozia reptans.
Lophocolea heterophylla.
minor.
Mylia anomala.
Odontoschisma denudatum.
Pellia epiphylla.
Plagiochila asplenoides.
Porella platyphylla.
Ptilidium ciliare.
pulcherrimum.
Radula complanata.
Scapania curta.
irrigua.
subalpina.
uliginosa.
umbrosa.
undulata.
—67.

12. The following additional species are common to Europe and America, but have not yet been reported from boreal Asia[1]:

Riccia natans.
sorocarpa.
Clevea hyalina.
Grimaldia rupestris.
Anthoceros laevis.
punctatus.
Aneura multifida.
sinuata.
Anthelia julacea.
Bazzania deflexa.
Cephalozia curvifolia.
dentata.
divaricata.
Lammersiana.
Chandonanthus setiformis.
Diplophyllum albicans.
Dicksoni.
obtusifolium.
Fossombronia Dumortieri.
Frullania fragilifolia.
tamarisci.
Gymnomitrium concinnatum.
obtusum.
Harpanthus scutatus.
Herberta adunca.
Hygrobiella laxifolia.
Jubula Hutchinsiae.
Jungermania capitata.
cordifolia.
Helleriana.
Hornschuchiana.
Michauxii.
riparia.
Kantia arguta.
Lejeunea calcarea.
serpyllifolia.
Lepidozia setacea.
Liochlaena lanceolata.
Lophocolea bidentata.
Marsupella brevissima.—*(M. adusta.)*
emarginata.
sparsifolia.
sphacelata.

[1] Twenty additional species from lower latitudes are common to Europe and America, bringing the percentage of European species exactly to 50. The remaining species are:

Riccia ciliata.
lamellosa.
nigrella.
tumida.
Sphaerocarpus terrestris.
Fimbriaria elegans.
Lunularia vulgaris.
Targionia hypophylla.
Anthoceros caespiticius.
Fossombronia cristata.
Jungermania laxa.
Lejeunea minutissima.
Rossettiana.
ulicina.
Lophocolea crocata.
Nardia hyalina.
Odontoschisma sphagni.
Pallavicinia Lyellii.
Pellia calycina?
Porella thuja? —20.

Metzgeria conjugata.
furcata.
pubescens.
Mylia Taylori.
Nardia compressa.
crenulata
scalaris.
Pallavicinia Hibernica.
Pellia endiviaefolia.
Plagiochila interrupta.
spinulosa.
Pleuroclada albescens.
islandica.
Porella rivularis.
laevigata.
pinnata.
Scapania compacta.
nemorosa.
Trichocolea tomentella. —62.

13. The following are common to Europe and Asia, but have not yet appeared in American collections:

Riccia minima.
Grimaldia pilosa.
Peltolepis grandis.
Sauteria alpina.
Cephalozia bifida.
connivens.
myriantha.
Jungermania Badenensis.
heterocolpa.
Jungermania Kaurini.
Limprichtii.
longidens.
Wenzelii.
Nardia Breidleri
Pellia Neesiana.
Prasanthus Suecicus.
Scapania apiculata.
rosacea. —17.

14. The two following are found in Asia and America, but not in Europe:

Cephalozia Macouni.
Plagiochila porelloides.

15. The following boreal and sub-boreal species are found only in Europe:

Riccia Michelii.
Clevea Suecica.
Aneura fuscovirens.
incurvata.
Cephalozia biloba.
Francisci.
integerrima.
Massalongi.
serriflora.
spinigera.
Hygrobiella myriocarpa.
Nevicensis.
Jungermania nardioides.
Jungermania rigida.
Marsupella alpina.
Boeckii.
condensata.
filiformis.
Funckii.
intricata.
obcordata.
varians.
Pallavicinia Blytii.
Pleurozia purpurea.
Scalia Hookeri.
Scapania Spitzbergensis.
—26.

16. The following are the endemic American species:

Riccia lutescens.
Aitonia erythrosperma.
Cephalozia extensa.
minima.
Sullivanti.
Chiloscyphus ascendens.
Diplophyllum argenteum.
Frullania Asagrayana.
Chilcootiensis.
Hallii.
Nisquallensis.
Frullania Oakesiana.
Selwyniana.
Jungermania colpodes.
Gillmani.
Groenlandica.
tesselata.
Vahliana.
Wallrothiana.
Lejeunea Macounii.
Lophocolea Leibergi.
Macounii.

Nardia crenuliformis.
Odontoschisma Macounii.
Porella navicularis.
Ptilidium Californicum.
Radula arctica.
Radula Krausei.
Scapania albescens.
Bolanderi.
glaucocephala.
Oakesii. —32.

17. Last of all are the ten species peculiar to Asia:

Calycularia laxa.
Diplophyllum plicatum.
Frullania Davurica.
Jungermania fertilis.
guttulata.
Jungermania quadriloba.
Sahlbergii.
Lophocolea reflexula.
Mylia verrucosa.
Porella grandiloba.
—10.

De Pauw University, Greencastle, Indiana.

Bacterial investigation of the sea and its floor.[1]

H. L. RUSSELL.

No class of living organisms, animal or vegetable, have been found to be so ubiquitous in their distribution as bacteria, yet strange to say, no especial attention has been paid to the investigation of the marine waters of the globe from a bacteriological standpoint. True it is that the phosphorescent forms of the sea have been more or less thoroughly worked out, and here and there other isolated forms have been described, but the general subject of the bacterial flora of the sea has been left quite untouched. It is not my purpose here to enter into any elaborate discussion of this subject, but only to give a short résumé of work along these lines which I have been carrying out for the past two summers, and also to suggest some problems of interest in connection with this subject.

I fully recognize the futility of attempting to draw any general conclusions from a comparatively small number of tests, but while the results which I have to offer may be regarded as somewhat provisional and will require extended confirmation before they can be accepted as general biological facts, I trust they may possess some interest even in thistenta tive connection.

The results, which I can only briefly summarize here, were obtained at the Zoological Station at Naples, during the

[1] Read before Section F, A. A. A. S., Rochester meeting, August, 1892.

spring and summer of 1891, and at the Marine Biological Laboratory at Wood's Holl, Massachusetts, during the past season.

These widely separated places, so different in many of their conditions, gave exceptional advantages for a comparative study along these lines.

Before detailing the results, I will state, in the briefest possible manner, the methods used in the work. First, in regard to the manner of procuring the material for examination: In securing this for a quantitative bacterial determination, it is necessary that the sample secured should be kept free from contamination, as far as possible, from the time it is originally taken until the growth of the cultures has been completed. To do this with material from surface-soil or air is not especially difficult, but when the material is to be derived from the ocean floor, or at varying depths in the water, the problem of keeping it uncontaminated during its withdrawal is by no means easy. The conditions must be such that the possibilty of contamination during withdrawal will be excluded. The apparatus which is quite universally used to collect samples of deep water for chemical and physical analysis is here of little use as it cannot be previously sterilized, but the following method which has been thoroughly tested for two consecutive seasons and has given most excellent satisfaction is believed to fulfil all the conditions necessary for the work.

It consists of a large sized test tube which is tightly fitted with a rubber cork having a single hole. The opening in the cork is closed by a glass tube which projects about three-quarters of an inch below the lower end of the stopper. The upper part of this small tube is bent at right angles to the long axis of the collecting tube and drawn out at a certain point to a finer caliber, so that it may be quickly sealed in an ordinary flame. The different glass parts are first sterilized by heat, the rubber corks being kept in mercuric solution, then rinsed in sterile water and finally dried on sterile filter paper. These are then tightly fitted together and a partial vacuum produced either by attaching the small tube to a vacuum pump or by expelling a portion of the air by heating the tube with a small amount of hot water or dry heat. The end of the small tube is sealed as the air is expelled. The vacuum tube may then be protected from gradual leakage by coating the cork with a mixture of beeswax and rosin.

To secure the samples of water from any desired depth, these vacuum tubes are attached to a holder by means of an ordinary clamp, the small drawn out glass tube being so arranged that the point of it lies near the connecting line that is fastened to the holder. When the holder with the vacuum tube has been sunk to the desired depth, a lead messenger is sent down over the connecting line and as it is caught on the top of the holder, the small glass tube is broken and the vacuum thus destroyed. The collecting tube fills quickly with water (usually from about two-thirds to three-quarters full) and then the apparatus is quickly hauled up. By virtue of the imprisoned air which can not possibly escape, owing to the projection of the small glass tube below the rubber cork and the rectangular bend in the tube, water is absolutely prevented from entering the tube after the first partial filling.

Cultures are made in the ordinary way by taking 1 cc. of the water after it has been thoroughly shaken up, mixing it with nutrient sea water gelatine and then plating it in Petri dishes instead of using the regulation Koch plate.

The apparatus which has been used to secure material from the sea bottom is theoretically imperfect, i. e., it does not fulfill one of the cardinal bacteriological canons—previous sterilization, but in its practical workings, I am satisfied that it delivers samples of the sea bottom quite uncontaminated from the water layers above. It consists of an ordinary iron tube (a gas pipe serves the purpose admirably) pointed at one end. The other end is fitted by means of a screw with a removable "sleeve," the upper end of which is closed by a valve. As the weighted instrument descends, the water passes through the pipe and as it strikes the sea floor, it is forced into the soil so that it is filled with a compact mass of material. As the instrument is withdrawn, the pressure of the water closes the valve from above so that no water enters the pipe during its withdrawal. The cohesive nature of the ocean slime is quite sufficient, except where pure "live" sand is present, to hold the mud column in the tube.

The mass of mud is removed from the tube by means of a piston rod, and from the center of this mass a known volume of the material is extracted by means of sterilized brass tubes. For this purpose a small sized cork borer is well suited. This known volume of mud is then diluted with a definite volume of sterile water and plated as in the other case. The only

possible chance for contamination is from diffusion which might take place from the sides and lower end of the iron tube. The material is within this for so short a time however, that in so solid and dense a mass as the mud core, this element of error has, I believe, little or no effect.

Attention may now be directed to some of the problems which arise in connection with the investigation of marine bacterial life. Space will only permit a reference to one or two phases of the work, and I can only briefly recapitulate some of the results which have already been obtained.

First, in regard to the presence of bacterial forms in the sea. To determine the bacterial content of the sea, it is necessary for one to secure material outside of the contamination limit from the land. This is of course a varying distance, depending upon the configuration of the shore and other conditions. Fresh water or sewage germs discharged into the sea soon perish on account of the change in their nutritive medium. Of course any quantitative determination of the bacterial contents of the sea must exclude all samples taken within this limit. To my knowledge, the surface water of the sea has not been analyzed bacteriologically at any great distance from land, but samples taken from the coastal line outside of land contamination show that micro-organisms are invariably present in the water. The number per unit of volume varies naturally within certain limits, yet there is on the whole quite a constant average number per unit of measure in these surface waters.

Examination of the *superficial* water layers has always revealed the presence of micro-organisms and it may be interesting to note in this connection the vertical distribution of germ life in the ocean. Are the marine waters peopled *throughout* with bacteria, or is this life confined to the warmer surface waters of the ocean? According to the researches of the Challenger, the marine fauna is separated into a superficial and an abysmal zone, while the intermediate depths are quite deficient in animal life. Analyses of the water at Naples taken at different depths from the surface down to a depth of 3,200 feet showed that bacteria were present in *all* cases. No zonary distribution was to be observed in any case and the intermediate depths as well as the water immediately above the sea floor were found to contain germs in about the same proportion as at the surface.

The usual content of the sea water ranges from 10 to 150 germs per cc., while in exceptional instances the number per unit of volume exceeded this; but the fact that the individuals present were in these cases usually of a single species indicated that the large number was due to a bit of zoogloea rather than active vegetative forms. A comparison of salt with fresh water shows that on the whole bacterial life is less abundant in the sea than in fresh water. The higher temperature of the latter and its proximity to land masses, which are nearly always extremely rich in bacterial organisms, are sufficient to account for this increase.

A bacteriological examination of the sea bottom shows that it, too, is filled with bacteria.

Observation demonstrates that the sea-floor is infinitely richer in germ life than the waters above it. A quantitative examination of the ocean bottom shows a wide variation in its bacterial contents. Just what factors bring about this difference in numbers, I am unable, as yet, definitely to state, but it seems more than probable, that the variable physical character of the sea flora, the depth at which material is taken, and the influence of temperature are conditions which largely determine the presence of micro-organisms. As might be expected, it will require an extended series of data gathered under similar as well as diverse conditions before the question of distribution can be satisfactorily explained. I shall only attempt to submit certain facts which have been brought out by the work, leaving a definite explanation until more thorough investigation.

At Naples, the investigation of the sea bottom was made from the shore line to a depth of 3,500 feet. At the depth of 150 feet and two miles from land, the sea floor contained from 200,000–300,000 germs per cc. From this number, it fell very rapidly as the depth increased until at the depth of 700 feet only 25,000 germs per cc. were present. From this depth to the deepest point investigated (3,500 feet) the number of germs remained tolerably constant. When these results are graphically represented, they show a marked coincidence with the temperature curve of the Mediterranean at this point. The Mediterranean being a closed basin is not subject to the general oceanic circulation and the temperature of the great mass of its water remains at a constant point. The summer temperature of the surface ranges from 77°–82° F., but this

falls rapidly to 55° F. at a depth of 600 feet, and from this point downward there is no change.

This season's work which has been carried on at Wood's Holl in much more northern and cooler waters shows that the bacterial content of the sea bottom is very much less abundant at this point than in the Mediterranean. In the vicinity of Wood's Holl I was unable to reach any great depth on account of the width of the shallow continental plateau which lies off southern New England and the middle Atlantic states. The number of bacteria per unit of volume was found to be, under similar conditions very much less than at Naples. The germ contents of the slime from Buzzard's Bay averaged from 10,000 to 30,000 germs per cc. This is scarce more than a tithe of what was present in the Mediterranean mud at equal depths.

When we find the mud so much richer in bacteria than the water, the question naturally arises, to what are these results due? Is the ocean bottom merely covered with the spores of the water bacteria that have finished their cycle of development, and then like the remains of the foraminifera slowly sunk to the bottom, or is bacterial life here present in its fullest activity? The answer to these questions may be sought in two ways. Qualitative analysis of the water and the underlying mud will demonstrate whether the species found in the two habitats are analogous or not. If we find the deposit made up entirely of species similar to those found in the water above, even though they may be very much more numerous, it is at least presumptive evidence that the mud owes its bacterial flora to the superimposed water masses. On the contrary, the presence in the mud of species which are *only* to be found in this habitat is evidence that the ocean bottom is filled with forms which are indigenous to this stratum. Qualitative analysis of the Naples mud showed three very prevalent forms which made up at least thirty-five per cent. of the entire bacterial content of the sea slime. These were wholly indigenous and were not found in any cases in the samples of water taken at any depth. A similar result has been reached in the work at Wood's Holl. Two species are most prevalent in the water, together with two or three other forms that are occasional inhabitants. Now the mud contains the two prevalent water forms, it is true, but in addition to this, there is another common form that usually makes up from thirty to fifty per

cent. of the whole number present, and is an indigenous slime bacillus. Besides this species there are two or three other species that are exclusively mud inhabitants although they are by no means so common as the one previously mentioned. I say exclusive, but this is not entirely true, for in two or three cases water cultures made at Wood's Holl have revealed species which had been supposed to be indigenous slime forms. These apparent exceptions can, however, be satisfactorily explained, for they were taken at localities where the tidal currents were strong and there is scarcely any doubt that they were detached from the mud by means of these currents much as the wind detaches bacteria from the soil and carries them about in the air.

The presence of these *indigenous* mud forms necessarily implies that they exist in a vegetative condition, but this can also be experimentally determined. Samples of the mud were taken and treated in the ordinary way in which cultures were prepared. The diluted material was then heated at a temperature sufficiently high to kill all the vegetative forms (80°C) but not enough to destroy the vitality of the spores. Cultures were then immediately made from the heated material and the actual condition of the individuals as they existed in the sample used, could thus be ascertained. These two sets could then be directly compared and the difference in the number of colonies gave the approximate number of vegetative forms actually present in the water or mud. This proportion is often a widely variable one but the analysis of a score or more samples show that the mud bacteria as well as the water forms are in a large degree in a vegetative condition, even under such adverse conditions for their development as those that are found at the bottom of the deep sea.

Mention has only been made so far, of the distribution of marine bacteria in general, but the vertical range of the different species also shows some interesting features. This bathymetrical range, *i. e.* the maximum and minimum depth limits of growth, which each species possesses, varies in different cases.

Great difference in depth means such a marked change in the environment of any single species that one might reason *a priori* that the same species would not be able to adapt itself to such widely different conditions. It is a well authenticated fact that such environments have brought out specific modifications in the faunal life of the sea.

Of the three most common mud forms found at Naples, the maximum depth limit of growth was not attained at the depth of 3500 ft. One of the three species *(Cladothrix intricata)* had nearly disappeared from the cultures, so that it was reasonable to suppose that the bathymetrical range had been almost reached. The other two species were at this depth sufficiently numerous to indicate that the maximum point of development had not been attained. This fact is of especial interest when we consider it in the light of the pressure experiments which have been carried out on bacteria.

Our knowledge of the action of high pressure upon bacterial metabolism is as yet imperfect, but there are several forms which seem to bear an increase of pressure of upwards of 100 atmospheres without material change.

A comparative study of the Mediterranean forms and those found on the New England coast gives an opportunity for a direct comparison from a specific as well as from a numerical standpoint.

The work during the present season has been mainly confined to Buzzard's Bay and Vineyard Sound off the Massachusetts coast, but through the kindness of Prof. Wm. Libbey, Jr., of the U. S. Fish Commission, samples of the mud were obtained about 100 miles from the shore at the depth of 100 fathoms. They were taken by the schooner Grampus on the edge of the great continental platform, which is skirted by the Gulf Stream. The samples are the farthest from land that have ever been analyzed bacteriologically, and give substantial evidence that the ocean bottom is peopled with bacterial life, to at least this distance from shore. Another interesting feature was determined by these analyses. The two prevalent slime species at this point were found to be the same as those taken from near the shore at Woods Holl. This proves a geographical distribution of the common mud species for at least 100 miles from land. A comparison of these forms with those at Naples shows a marked dissimilarity. The number of indigenous forms in the water and mud is not especially large in either case. One of the most interesting species found in the Mediterranean is an endosporous, pseudo-branching form, Cladothrix intricata, which was there quite frequent, but a rare species on the Atlantic coast. This indicates that this species, at least, is quite cosmopolitan in its distribution. Aside

from this form, the other species were quite unlike, although they possess some similar characteristics. The bacteria that are so universally present in sea water and mud seem to be quite peculiar to this habitat. Of course many land and fresh water forms are carried into the sea by drainage, but sooner or later, most of them succumb to the changed conditions of their existence.

With this *introduced* or *adventive* flora, we are not especially concerned, but aside from this, there are these certain well defined species, that seem to be indigenous to this particular habitat. By long residence in salt water, some of them have become so modified, that they grow much more luxuriently upon media made from sea water than upon that which contains only the normal amount of salt. In one of the species isolated at Naples, this specialized saprophytism was as well marked as in the case of certain pathogenic species which are cultivated upon artificial media with only the greatest difficulty. Time will not permit any further discussion of this question of marine microbiology and these disconnected statements will be closed with a few suggestions as to the more important problems presented in this line of work.

Aside from the subject of geographical and vertical distribution of bacterial life and the forces which produce these results, there are various problems which possess a morphological as well as a physiological interest. For example, the inner structure of the bacterial cell—the relation of the karyoplasm to the cytoplasm and the cell membrane—a subject which at the present time in this group is imperfectly understood can, I believe, be better demonstrated with marine species of bacteria than the great majority of other forms. As a rule, the individual cells are relatively large and the protoplasm instead of being homogenous is highly granular.

Besides these morphological questions, there are many of a physiological character, such as the relation of bacteria to phosphorescence; their connection, if any, with deep-sea decomposition; the influence of high pressure incident to depth; and the changes in their oxygen supply, which might be profitably considered.

Much of this class of work can be best done under the auspices of the government, either by the Fish Commission or the Coast Survey, as these departments are already provided with the necessary outfit of vessels fitted with suitable dredg-

ing apparatus, etc., for deep sea work. Unfortunately, the methods of work preclude the use of preserved material, as this subject can only be prosecuted by means of culture work. Not only would such a department of research upon our scientific exploring expeditions add greatly to our knowledge of bacterial life, but the lower forms of fungi could be investigated as well.

University of Chicago.

A peculiar case of plant dissemination.

EDWARD L. BERTHOUD.

Studying lately with intense interest "Island Life," by Alfred Russell Wallace, and his remarks upon the dissemination of plant life everywhere, both on continents and islands, it brought to my mind what many years ago I had observed during a long residence, and numberless scouts, excursions, surveys and pleasure trips I have made in the region included between the Missouri river and Great Salt Lake, and from the 34½° N. latitude to that of Eau qui Court in Dakota, and Sun river in Montana.

As these may be of interest and some value in the determinations of geographical botany, and have a bearing in the elucidation of geological botany, I will briefly give the more salient points of these observations. I can show to some extent that between the Missouri river and the Rocky mountains, the American buffalo has been an efficient agent in plant dissemination. Until within twenty-six years the buffalo was known to range from Peace river and Athabaska valley to central Texas. Very much as our Indian tribes are known to do, the buffalo uniformly followed trails in their annual migrations from north to south, or *vice versa*, very rarely deviating from them, whether across prairie or woods, or over spurs of the Rocky mountain range, on their migrations through South, Middle, North Park and Laramie Plains. And when in the spring the former countless herds from Texas moved north across the Arkansas, Smoky Hill, Republican and Platte rivers, the same trails were used, the same river fords crossed, and, following the best ground for their migrations, their sagacity or instinct (if you choose so to call their

inherited faculty) made them follow trails over the lowest and best divides between streams.

When following large herds in Nebraska, Kansas, Colorado, Indian Nation and Texas, we have seen these trails in soft rich ground worn down five or six feet deep, thirty or forty feet wide, as well defined as a graded wagon road.

We have spoken of their migration only in a sense restricted to our personal knowledge in the region we have already described. Yet from the best information we can get we find that this same yearly change of locality occurred in northern Idaho, Montana and Dakota, and north of the Black Hills, not so much from scarcity of forage, as the necessity of shelter from the winter snows and blizzards of the upper Missouri and Yellowstone prairies; while in British America, according to the accounts of Franklin, Richardson, and also Messrs. Milton and Cheadle for the Saskatchewan and upper Athabaska valleys, the buffalo were driven by snow and intense cold from the open country into the timbered valleys, and forests west of the open plains and in the Athabaska region.

In the spring the general movement of the buffalo was north into Nebraska, Colorado, Wyoming and Kansas across the Arkansas river, then north to lat. 44^0 or even farther, and largely governed by the more or less abundance of grass and water, but as early as May vast herds were already in the Platte valley, invading the vast prairies of Dakota and Nebraska. In the fall the returning herds would be seen in October in the Platte valley, or even as far as the Arkansas.

These points explained and shown, we will now explain in what manner this bears on the question of the dissemination and intermingling of plant life within the limits given in this discussion.

The American buffalo, a good deal as their congeners in the eastern hemisphere, delight in rolling and plowing up with their horns the soft, muddy soil of the prairies, or of any bluff bank; rolling around they formed countless numbers of shallow depressions, circular in shape, very often retaining rain water for days, which were familiarly known as "buffalo wallows."

So that along deep, wide trails, and in the wallows, the sod being worn away, and the soil loosened and trampled up, large areas would be conspicuous by nourishing and perpetuating a new growth of plant life, introduced, generally or altogether foreign to a prairie country, and of such species as found these conditions favoring their growth.

We would find there Plantago (2 species), Asclepias Syriaca, Trifolium, Thlaspi, Amarantus, Chenopodium album, Martynia proboscidea, Sinapis, Portulaca, Lippia cuneifolia, and the grasses, such as Cenchrus, Stipa, Setaria, Elymus, Dactylis, Deschampsia, Panicum Crus-galli, Euphorbia, Glycyrrhiza, Epilobium.

We could add to this list Helianthus, but as this plant is firmly established as a native to the soil of this whole region, and universally appears along old roads and in all the valleys, its dissemination seems to be largely independent of artificial dissemination, and dependent for its spread solely on the bared condition of the ground when sodless. We have so far given what annuals or biennials are found in the artificial denudations made by the buffalo. To these we can add Rhus glabra, and a plum called "sand plum," a low spreading bush, two feet or less in height, abundant south of the Arkansas and in the Indian Nation. It was found by me near old buffalo trails in north Colorado, up to near North Platte in Wyoming. The same can be said of Rhus glabra, which in Colorado, at the foot of our Rocky Mountains, has been introduced since 1860; and found in Wyoming as far north as the forty-second parallel: the plum might be, perhaps, the Prunnus pumila, but may be only a variety of P. Chicasa, though I can hardly admit this as probable.

Now how do the buffalo distribute all these plants and shrubs, which so fix themselves in the places artificially formed in this whole vast region? An inspection of the enormous pad of hair four to twelve inches long that clothes the whole front of the buffalo's head from the root of the horns nearly to the muzzle, besides the dense long hair that clothes the legs and breast of the animal, reveals masses of hair, matted with mud, seeds, twigs cactus fronds and roots.

When examining the heads of dead buffalo I repeatedly noticed, matted in the long hair of the forehead, the woody two-tined capsules of Martynia with the seeds of the plant; also seeds of Bidens, Glycyrrhiza, Stipa, Setaria, Elymus, the seeds and pappus of Helianthus and other unknown Compositæ, hispid twigs of Euphorbia, and seeds of some species of Rhus, perhaps R. trilobata very common in Colorado, seeds of Obione canescens, and seeds either of Amarantus or Chenopodium. The pad altogether made up an ambulant Wardian case.

Now such a pad of hair (overlooking the breast and legs of the animal) matted as we have said, and daily rubbed in earth banks or wallows, is as good an apparatus for artificial dissemination as could be imagined when we consider the range and habits of the animal. Given a herd of ten thousand buffaloes roving from the Red River of Texas to northern Nebraska and Montana, we can justly imagine that the seeds of southern species of plant and shrub life would in time be left at intermediate points most favorable to their growth, while the returning herds in the fall and winter would be laden in the same manner with northern plant seeds to be in their turn dropped or left many miles south of their former habitat. Nor s it necessary that any one species of the plants should be conceived as forcibly carried from Texas to Montana by one migration; on the contrary taking the case of Martynia, a seed brought from Red river is dropped in a favorable spot on the Arkansas in some trail or wallow. There it matures seeds mayhap for years; some of them are again entangled in the forehead or the front woolly hairs of a buffalo on its neck or fore legs and are finally dropped by chance on the Smoky Hill or Republican The same actions may recur, and the plant seeds be carried into the next valley or to the next prairie divide, so that in course of time it is not at all improbable that any one species of plant would finally reach the uttermost northern limit of the buffalo's northern range, the plant being, as it were, slowly acclimated by the successive transference from age to age in its continued dissemination. What we argue in relation to the Martynia, can equally apply to any plant or shrub seed, varying in its northward or southward progression just in proportion to its adaptability to withstand heat or cold, drouth or moisture, and its adaptation to extraneous transportation.

Now, if we turn to Richardson's Appendix to his Arctic expedition we find that he gathered *Opuntia glomerata* at the Lake of the Woods, while others have found it since near Lake Winnipeg. The occurrence of such a southern type of plant about latitude 50° to 51° north, we believe was largely due to a progressive dissemination by the buffalo, not only by seed, but also by direct conveyance of fronds and roots. This transfer we conceive highly probable, as well as that of many other plants and shrubs that range into British America from as far south as latitude 35° and 36°. We are certain

the sand plum has advanced from the Arkansas river into northern Colorado and Wyoming, since in the scope of the buffalo country extending from the forks of Platte river to the Rocky Mountains, I have found it only where the main buffalo trails formerly existed. Rhus glabra is, however, such a cosmopolitan shrub, that its dissemination north may be as justly ascribed to recent settlement as to the artificial dissemination we have advocated.

Again, if the fossil sequoias, figs, magnolias, oaks, palms, liquidambars, cycads, salisburias, laurels, persimmons, cinnamonums, aralias, sassafras and many other semi-tropical or south temperate trees and shrubs now found in the Cretaceous, Eocene and Miocene beds of Colorado, were derived from the Arctic regions originally; and if their modified descendants now found extant from the Missouri river south to the Mexican gulf are their living representatives, then it is quite remarkable that no representatives of the cactus family occur either in Greenland strata or in the same formations in Colorado. Their total absence also from the Pliocene strata of South Park, so rich in Sequoia, Glyptostrobus, Myrica, Rhus, Sapindus, Ficus, Planera, Cesalpinus, Acacia, Zizyphus, Ilex, etc., though really only negative evidence of their non-existence there, is strongly corroborated by the fact that the Opuntia is a plant that avoids damp, densely timbered surfaces. It delights in dry, stony, sandy soils, and requires but little water the whole year round. The vegetation of the Cretaceous, Miocene, Eocene and Pliocene strata in Colorado predicates the presence of rich, damp soils, either of valleys or low humid plains. Although the presence of fossil cacti has never yet been proven in any of the formations we are now considering, the fleshy nature of the fronds of Opuntia would naturally be very unfavorable to fossilization; but its abundant seeds of a very hard consistence, would be unusually well fitted for preservation, for we find to-day in the strata under consideration fossil nuts of Fagus, Corylus, Carya, Diospyros and a species of plum, besides palm nuts, fern fronds with sporangia complete, seeds of grasses and carices, also of elm and Planera.

The reader may ask what has all this to do with the question of "buffalo pads." The answer is simple enough. We think we prove very strongly by this that the cacti that extend from southern latitudes to Lake Winnipeg, are colonies that in the

course of ages have been gradually acclimated by artificial dissemination, and not the fragments of a flora derived from Arctic regions. Granting this, then the same method would apply to Clematis Virginiana, Negundo aceroides, Ampelopsis quinquefolia, Prunus (Cerasus) serotina, Cornus, Shepherdia argentea, Sambucus pubens, Hypopitys; all found according to Richardson far north in the British possessions, within the old buffalo range, but also common as far south as latitude 35° north.

Golden, Colorado.

Notes on certain species of Erythronium.

E. B. KNERR.

Perhaps there is no more interesting genus of plants among Liliaceæ than Erythronium. The species are the first of the order to appear in the spring and in point of beauty are second to none. Besides, there are features of propagation quite as puzzling and wonderful as any to be found.

Of the three species to be mentioned *E. Americanum* Ker. is the most common in the eastern states, *E. albidum* Nutt. in the central and western states to Kansas and Nebraska, while *E. mesochoreum* Knerr belongs to the states of the lower Missouri valley. All three species present two kinds of plants: a flowering two-leaved and a flowerless one-leaved form, both of which arise from underground corms. In the flowering forms these corms, or rather fleshy bulbs, consist of a series of corms arranged somewhat spirally one within the other, sometimes as many as four or five in number, the youngest innermost, each corm producing its plant in succession a year apart and beginning with the oldest and outermost. Sometimes, however, in E. mesochoreum and E. Americanum it happens that two and even three of these corms may develop at once, producing as many leafy scapes apparently from the same root, when ordinarily but one would be expected. As yet I have never noticed this in E. albidum.

The sterile forms (one-leaved) both of E. Americanum and E. albidum, and sometimes the flowering, send out underground off-shoots or rhizomes which produce at their extremities new corms destined to furnish the plants of the next season. In the two species, however, there is this difference:

E. albidum usually sends out but two (though sometimes specimens are found with but one such rhizome), a strong vigorous one and a second that is weaker and smaller. In E. Americanum the number is usually from three to five, successively diminishing in size, all more or less coiled and twisted. In E. albidum they are much straighter and somewhat deeper rooted. E. mesochoreum never produces such rhizomes, so far as we have observed, either in the one-leaved or in the two-leaved forms.

Herein we readily find an explanation for the multitude of the one-leaved forms of both E. albidum and E. Americanum wherever they occur; for in the case of the first species where this year was but one plant, next year will be two; and in the case of the second species even a greater number will appear, a plant for each new rhizome. Thus it is that whole slopes of shaded ravines become carpeted with these beautifully mottled leaves. Only one here and there of the thousands is destined to develop a corm without offshoots, which in a season or two may send up a flowering scape to produce seed and propagate its species sexually.

Right here arises an interesting question: What selective power is it that determines the one in the ten thousand, which is thus to reach fruiting?

We are reminded that this same question arises in other branches of biology wherever propagation is secured by both the asexual and the sexual processes. The reply usually given is that the conditions lie in the food supply, a very plausible answer for the most part, but we seriously doubt its sufficiency.

As such rhizomes producing corms at their extremities are entirely wanting in E. mesochoreum, sterile forms in this species are comparatively rare, and those that do occur are seedlings soon to become fertile flowering forms. Hence it is that where this plant is established there is no lack of bloom in the flowering season.

The leaves of E. albidum and E. Americanum are very similar in appearance, being both very conspicuously mottled with various shades of green and purple, especially in the early part of their blooming season; but those of the latter species are usually broader and flatter than those of the former. We have noticed that this mottling disappears to a great extent, especially in E. albidum, as the season advances, the color be-

coming almost a uniform bright green and then fading to yellow as the leaves wither. But as yet we have sought in vain for unmottled forms of *young* E. albidum mentioned in the botanies. The third species, E. mesochoreum is never mottled, especially when young, though we have found a few specimens that showed a faint mottling in lighter shades of green when the season was much advanced. The leaves of this species are also much narrower and longer than those of either the other two, being mostly linear-lanceolate, and indeed even linear in some specimens.

The habitat of these plants is also characteristic, E. albidum and E. Americanum preferring deep-shaded ravines and moist meadows, while E. mesochoreum takes to the hill-tops and the north facing slopes whether wooded, or open and covered with grass.

The color of the sepals is also distinctive, E. Americanum being yellow with purple dots at the base, E. albidum white tinged with pink, and E. mesochoreum also white, but tinged with lavender or blue. The perianth of the last is usually much longer than that of E. albidum and is not so much reflexed in the bright sunshine.

The stigmas of E. Americanum are peculiar, being massed into a club-shaped body; those of E. albidum are quite divergent and somewhat recurved; while in E. mesochoreum they are more slender and decidedly recurved. The capsules of this last species are also much larger and longer than those of either the other two and everything indicates that the seed is also more vigorous, a fact naturally to be expected seeing that this form propagates rather sparingly by the bulb.

Midland College, Atchison, Kansas.

BRIEFER ARTICLES.

Notes upon Daucus Carota.[1]—The early introduction of this plant, from its European soil and environments, and its present wide distribution, and ready adaptation to new conditions make it a good type from which to expect those variations of habit, structure, etc., which usually attend the transplanting of a new organism with new conditions. Records of the numerous changes which it has undergone

[1]Read before Section F, A. A. A. S., Rochester meeting, August, 1892.

prove that it is no exception to the general laws of variation. Leaving out of all account the extended variation among the cultivated varieties which are quite as marked as among others of its congeners, my purpose in this note is to call attention to the range of variations to be found in the weed in a state of nature. This tendency is quite marked, and has often been noted. One of the more common and constant phases of variability is to be fouud in the floral umbel. The presence of a single, central flower, springing from the immediate center of the disk, and of a deep purple color, in distinction from the generally pure white of the entire umbel, is a feature that has been known for some time, though I am not aware that any record has appeared in any recent literature.

Another feature nearly as general and constant is the presence of a peripheral circle of larger flowers, mostly sterile and radial, though this is not universally the case, and for this reason, as probably in the preceding case no special record has been made of the fact.

During the present summer I have observed certain other variant phases which seem to be somewhat new, as a very considerable extent of inquiry among leading botanists has failed to elicit any corresponding observations. The features to which reference is here made are two. *First:* The extension of the unique colored and sterile features of the central flower to the whole central umbelet. This I have noted in quite a large number of cases. *Second:* The implication of the entire umbel in the coloration. This feature was by no means as general as the last, but was quite marked in many individuals. My first thought upon observing it somewhat casually was that it was probably due to the same cause which leads to the assumption of purplish hues by many white flowers as they age toward withering. Subsequent observations, however, showed that this could not be the case; as in those plants exhibiting the phenomenon at all, it was quite as marked in the earlier phase of flowering as at any other. This, together with the observed tendency of the central purple flower to involve the whole central umbelet in its peculiar color, renders very strong the conviction that it is a case of variation, which in time may become quite general and permanent.

My first observations on these points were made in the vicinity of Cold Spring, L. I., but have subsequently been verified upon specimens in this vicinity, and I doubt not may be found occasionally in many localities, though I had not noticed them at all in the middle western states.

It is quite remarkable that notwithstanding these and other features of variation, the divergence has not been sufficiently marked or con-

stant in any one direction to give rise to new species, or even to well marked varieties.—CHARLES W. HARGITT, *Syracuse University, Syracuse, N. Y.*

Cross and self-fertilization.—In a series of experiments, still in progress at this college, on the fertilization of the common petunia, the following results were obtained from the first generation.

One dozen petunias of equal vigor were selected from the greenhouse cuttings, and put into pots of equal size, and subjected to exactly the same conditions. About half of the plants were the dull purple variety, nearly the original type, while the others were variegated and somewhat modified. Each blossom was very carefully excluded from accidental fertilization, by being tied in a paper bag, or by having the corolla tied together tightly until the capsule had begun to develop.

There were three series of experiments. The blossoms of series I were self-fertilized; those in series II were fertilized from other blossoms on the same plant; and in series III they were fertilized from other plants.

Series I bore capsules averaging 1.8 centigrams in weight, series II bore capsules averaging 2.7 cgms. in weight, and series III bore capsules averaging 4.1 cgms.

In series I and III, the seeds of the plain purple and the variegated specimens were weighed separately, showing the variegated to be lighter. In series I the purple weighed 0.7 cgm. more than the variegated in the same series. In series III the purple bore capsules 0.2 cgm. heavier than the variegated in the same series.

It was also noted that many more capsules in series III developed and ripened perfectly than in either series I or II; while series I ripened the smallest percentage of capsules. Owing to various accidents no definite figures could be obtained to show the exact proportions.

Thus it may be inferred that even in the first generation the deteriorating effects of self-fertilization are plainly shown; and also the tendency of much modified plants to decline in vigor and productiveness.

Darwin, in his book on cross and self-fertilized plants, page 189, says: "In crossing six blossoms, there were six seed capsules produced, weighing 4.44 grains; while six others were self-fertilized, producing only three capsules weighing but 1.49 grains."

This experiment is interesting from the fact that it agrees with Darwin's very similar experiment on the same plants.—MINNIE REED, *State Agricultural College, Manhattan, Kas.*

CURRENT LITERATURE.

Last volume of a great work.[1]

The task of collecting and issuing in uniform manner all the specific descriptions of fungi ever published, although requiring prodigious labor, has been accomplished by the author of the Sylloge Fungorum in a remarkably short time, and the final volume now lies before us. The ten volumes of the work contain about forty thousand species. How many of these names are synonyms is the part of the monographer and special student to determine. Excellent judgment has been shown throughout in the compilation, and the work will not only be a monument to the perseverance of the author, but of inestimable and lasting service to mycologists.

The present volume does not differ essentially in its make up from the preceding, except in possessing a universal index to the cohorts, families, genera and their synonyms of the full ten volumes. The series closes most appropriately with an enumeration of fossil fungi, embracing 331 numbers, compiled by Dr. A. Meschinelli.

Although this is the last volume of the work as projected, Dr. Saccardo offers to issue addenda, if authors will kindly continue to send him their publications. He states that at the time this last volume came from the press (June, 1892,) some fifteen hundred species, *incredibile dictu*, had already come in, too late to be included. Such evidence of activity in the collection and study of fungi indicates how highly serviceable such addenda must be to all working botanists.

The flora of the Dakota group.[2]

This invaluable contribution to the fossil flora of North America was the last work of Leo Lesquereux, who died in the fall of 1889. It is composed of a vast number of leaf-drawings, identified and named by the deceased author, and portrays the forests that once existed in this country. At the same time it shows the broad range of this scientist's work, whose childhood was spent among rocks, trees and flowers in the heart of Switzerland. From these early influences Lesquereux naturally turned in time to the study of botany, to which he devoted the greater part of his life. In the year 1848 he came to

[1] Saccardo, P. A.—Sylloge fungorum omnium hucusque cognitorum. Vol. x, supplementum universale; Pars II, Discomyceteæ—Hyphomyceteæ, additi sunt fungi fossiles auctore Doct. A. Meschinelli. Roy. 8 vo, pp. 964. Patavii, 1892. —Francs 48.

[2] Leo Lesquereux.—The flora of the Dakota group, a posthumous work, edited by F. H. Knowlton, U. S. Geol. Survey. 256 pp., 66 plates. Washington, 1891.

America to become our foremost paleobotanist. His great enthusiasm soon made him familiar with our flora, and we need only to look at the work he has left us to get an idea of his talent and indomitable energy. His last, as well as his previous works are well fitted to stimulate our paleobotanists. As it will be impossible to give a complete review of this voluminous work, we point out a few of its characteristic features, as shown in the original way, by the author himself.

How full of interest, for instance, are the figured leaves of *Liriodendron*, illustrating the transition to ancestors with deeply lobed or even pinnatifid leaves, sometimes of gigantic size, but with the characteristic truncate apex, until another form appears with the terminal lobe preserved as in *L. semialatum*. The comparison of these very different types might seem hazardous, did the carefully drawn figures not show a striking accordance. We note one exception only: the nervation of the leaf (plate XXIX, fig. 3) appears somewhat different from a true *Liriodendron*. Comparing the genus *Sassafras*, we find a large, five-lobed leaf with margin entire (*S. dissectum*), while *S. cretaceum* var. *grossidentatum* and *S. papillosum* show similarly lobed leaves, but with dentate margins. These last forms seem, however, hardly to belong to the genus *Sassafras;* the leaf figured on plate VI, fig. 7, agrees in most respects with a leaf of a *Platanus*, closely related to *P. occidentalis*. We wonder also why the author did not consider the leaves of *Sassafras dissectum* and of *S. subintegrifolium* (plate XIV, figs 1 and 2) as one species, since these two forms are easily recognized in our recent *S. officinale*. We find, too, a number of leaves of Heer's *Betulites* united into one species by Lesquereux, who gives in the text a most valuable account of the variation of leaves on this tree, and calls attention to the fact, that if these leaves had been found separately, at different times and in different localities, they might have been referred to a number of species.

There is, altogether, in this work — not only in the text, but also in the numerous illustrations — abundant material for further studies. Besides describing and enumerating the species of the Dakota group, as far as it is known at the present time, including ferns, cycads, conifers and phanerogams to the number of 460 species, the author gives an analysis of the entire flora. A general sketch of this highly interesting flora is given with critical notes upon the types occurring there, for instance of *Liriodendron, Sassafras, Quercus, Ficus* and many others. The study of these plants has led to the conclusion "that the flora of North America is not at the present epoch, and has not been in past geological times, composed of foreign elements brought to this continent by migration, but that it is indigenous; its types are native,

and the diversity of their representatives has been produced by physical influences. The affinities, therefore, or the relation of their modification or derived forms can not be looked for in the vegetation of distant countries."

As the work is left by the author, although unfinished, it commends itself, and the author's name will always be remembered with admiration and gratitude. But we are unable to leave his work without a few remarks about the manner in which it has been edited.

In looking through this book, we are surprised at the number of errors, apparently of carelessness, such as mis-spelling, incorrect citations, omission of figures, misleading terms, etc. The editor seems not to have understood the responsibility of editing a posthumous work. The best method of editing a posthumous work is, undoubtedly, to carry it out in the same spirit in which it was started, taking all facts into consideration. It must not be forgotten that Lesquereux was an old man, who, in the later years of his life, became unable to keep informed as to recent publications, and that his views in some respects belonged to past times. Then, too, there are many things that are admissible in a manuscript, written as the thought first comes to us, and pleasing for the time to the fancy, which should be omitted in print. We dare say, that in its present form, this work would never have been published by the author. The reader will readily observe the wide gap between the genial and elegant work of Lesquereux, and the lack of care and taste in the present edition.

Although it is as unpleasant a task to criticise a posthumous work as it is delicate to edit it, we must note some of the deficiencies in the edition. The plates, which form the most important part, and which should have been a guide to further studies, are poorly arranged. The genera ought to have been so placed as not to require one to look over a large number of plates, widely separated from each other, to find the species of each genus. This is the case, for instance, with *Protophyllum*, *Ficus*, *Sassafras* and most of the large genera. It would have been an easy matter to arrange them in good order. Several of the figures are designated by numbers so distant from the respective illustrations that it is hard to tell to which figure the numbers belong. Some of the illustrations are not named at all, and others are not numbered. The spelling of names is inconsistent in a great many instances: we have both *grossi-* and *grosse-dentatum*, *cissioides* and *cissoides*, besides numerous others. Often the specific name is of the wrong gender as: *Fagus orbiculatum*, *Sassafras primiginea*, *S. artica*, *S. Pfaffiana*, etc. The descriptive part contains some misleading phrases; e. g.: "dots like the impression of basilar points of hairs"

(p. 98), "a bunch of small pediceled seeds like those of *Carex*" (p. 62). Furthermore there is a too indiscriminate use of terms: e. g., basal, basilar and basil — the last of which is the name of a plant, but is written in the manuscript as an abbreviation of basilar. In the descriptions of the nervation it is a difficult task to understand the terminology. From *Protophyllum denticulatum* (p. 193) we cite the following: "median nerve," "lateral primaries supra-basilar," "secondaries with their divisions," and finally, "nervilles!" The nerves figure under several names: veinlets, nervilles, etc., which are not technically correct. On page 92 we learn that "the nerves are attached to each other." Again it is remarkable that such an expression could escape the editor's attention as this from p. 243: "*Diospyros Virginiana* being the only species remaining in the present North American flora." Such mistakes might easily have been corrected, but we are sorry to say that these and many others have been allowed to pass by the editor whose duty it would seem to have been to correct them.

We regret that this valuable work of Lesquereux has not met with a more satisfactory treatment as to correctness and form. The spirit and skill of the author has failed to find in the editor due appreciation and sufficient painstaking for so important a work.—Th. Holm.

The Minnesota Catalogue.

In the present confusion of ideas with regard to the larger groupings of plants it is as well, perhaps, for authors of local lists as well as more extended manuals to try to express our present knowledge of plant affinities. Such an attempt is now before us in Professor Conway MacMillan's introduction to "the Metaspermæ of the Minnesota valley." This introduction, reprinted in advance, is intended to be a statement of the principles and classification to be followed in the forthcoming enumeration. The principles enunciated are those familiar to all who consider the subject of nomenclature, which is now in a fair way to be so happily settled. We much regret that so sprightly a young author should see fit to include in this part of his very readable pages any insinuations as to unworthy motives governing those who are counted as conservatives in this matter. Differences of opinion there must always be, but courtesy demands that a man shall be taken to be honest in any public expression of his views. As to the proposed groupings: two great divisions are used, Protophyta and Metaphyta, based upon the absence and presence of sexuality. Metaphyta are further subdivided into Gamophyta and Sporophyta, dependent upon the development or not of a distinct sporophyte. Sporophyta are then subdivided into Thallophyta, Archegoniatæ, and Metaspermæ, whose names practically describe their limitations, the last named including

angiosperms. In grouping the Metaspermæ Treub's conclusions from the study of Casuarina are accepted, and the groups Chalazagameæ and Porogameæ adopted, dependent upon the absence or presence of a micropylar canal. The Porogameæ contain monocotyledons and dicotyledons; the latter being further subdivided into Archichlamydeæ and Metachlamydeæ, the former being a combination of Polypetaleæ and Apetalæ, the latter the Gamopetalæ.

Special attention is called to the definitions of Metaspermæ and Archispermæ (Gymnospermæ), which includes our knowledge of the difference in the origin of the so-called "endosperm" in the two cases and the still somewhat obscure notions as to the sexual origin of the angiospermous "endosperm." Our present knowledge and theory with reference to these very important but very recondite distinctions are well and compactly put, but we may be pardoned the question whether the language is not too severely technical to be addressed "not to any coterie of *savants* in some special line of science, but to the general public of Minnesota." Professor MacMillan has undertaken a very interesting piece of work, and with a vigor of style and freedom from restraint that will surely bring useful results.

Minor Notices.

Dr. N. L. Britton has published a synoptical list, including synonymy, range, and descriptions of new species and varieties of the species of Scirpus and Rhynchospora occurring in North America.[1] Of Scirpus 36 species are enumerated, including the new *S. Peckii* of N. Y. and Conn. Rhynchospora presents sixty species, sixteen of which are Mexican, West Indian, and South American.

Dr. Trelease has long been studying our Yuccas, a sort of heritage from Dr. Engelmann, intensified by his own interest in all that relates to pollination. The story of Yucca, told by Dr. Engelmann, Professor Riley, and Dr. Trelease, is a part of the pyrotechnics of our science, so wonderful that seeing is almost necessary to believing. Dr. Trelease had intended to give to the public a summary of the whole subject, together with the results of his recent studies both in the Botanical Garden and in the native haunts of Yucca, but Professor Riley has undertaken the work from the standpoint of Pronuba. We have left, however, in the reprint before us[2], a synoptical list of our

[1] Britton, N. L.—A list of the species of the genera Scirpus and Rhynchospora occurring in North America. Contrib. Herb. Columbia Coll. no. 26. Reprinted from Trans. N. Y. Acad. Sci. XI, pp. 74-94.

[2] Trelease, William.—Detail illustrations of Yucca and description of Agave Engelmanni. From the 3d Ann. Rep. of the Mo. Bot. Garden, pp. 159-168 with 25 full page plates. Issued May 28, 1892.

Yuccas and illustrations of thirteen of the species. Eleven plates are devoted to the display of such characters as enter into the delimitation of species, while twelve reproductions of photographs show finely the facies of the different species. A new Agave, *A. Engelmanni*, is also described and figured.

OPEN LETTERS.

Who are biologists?

Botanists will feel grateful to Prof. MacMillan for his vigorous protests against the present unfortunate attitude assumed by zoologists in regard to the position of botany as one of the biological sciences. This question is one which vexes us here as well as elsewhere, but since my connection with the University we have been insisting upon a recognition—by our students at least—of the place in biological studies to which botany is entitled, and I am glad to say that there is a disposition among some of the best of our zoologists here, to grant what we claim in this respect. The question is an important one in many ways, and it has occurred to me more than once, that it would be a proper one for action by the Botanical Club in the first instance, and then, if possible, by the Biological Section of the A. A. A. S. Certainly the botanists of the United States and Canada are a sufficiently numerous body to make any serious representations from them of value. Were action taken by them in this case, and their position firmly maintained, I think it would have considerable weight in settling once for all what is a most unnecessary annoyance and injustice to an important profession.

The Madison meeting is to be an important one. At it will be gathered, it is hoped, not only all our own best men, but a number of representative men from abroad. There could be no more fitting opportunity to bring this question forward and have it freely discussed, and the present is none too early to suggest such a movement.—D. P. PENHALLOW, *McGill University, Montreal.*

Variations of the strawberry leaf.

The article of Mrs. Kellerman in the August number of the GAZETTE suggests the following: In May, 1889, I noticed upon specimens of *Fragaria* which were brought into the laboratory, additional fourth and fifth leaflets upon the petiole below the normal leaflets. Turning to Bentham and Hooker, Genera Plantarum, under Fragaria, I found "*Folia alterna, 3-foliata, rarissime foliolis paucis lateralibus adjectis pinnata v. 1 v. 5-foliata.*" I determined to search for more examples with a view of ascertaining whether the variation was rare or common in this locality.

In June of the same year, while collecting with half-a-dozen students in the vicinity of Willmette, we all so frequently found the leaves bearing the additional leaflets that we concluded that they could be spoken of as "not uncommon in this locality." October 20, 1890, I found them plentiful at the side of the railroad north of the Ridge viaduct

in a patch of ground which may have been formerly part of a garden. Of fifty leaves taken at random twelve had extra leaflets upon the petiole. Of these twelve, eight had two leaflets, opposite in four cases and alternate in four, and four had single leaflets upon the petiole below the normal leaflets.

May 7th, 1891. I found the extra leaflets abundant in the locality just mentioned and also upon our north campus near the lake shore. When picking at random one in every four or five had the extra one or two leaflets.

In July, 1891, I found in the herbarium of the Natural History Museum, Kensington, London, two specimens of Fragaria Virginiana, one collected in Colorado and the other at Kettle Falls upon the Columbia river, which had the supernumerary lateral leaflets.

My observations tend to the conclusion that in some localities twenty per cent. of the leaves of Fragaria have five leaflets, two of which usually disappear as the season advances leaving the normal trifoliate form.

Mrs. Kellerman, from the variations which she has noted, reasons that the strawberry is developing a quinquefoliate form of leaf. By the flight of his imagination in "The Evolutionist at Large," Grant Allen shows how the "fruit" of the strawberry may have developed from a potentilla; while the facts given above seem to indicate that the plant, so far as the leaves give evidence, is passing or has passed from a pinnate form, not unlike certain potentillas, having five or more leaflets, into a trifoliate form. These observations were made both upon Fragaria Virginiana and upon its variety Illinoensis.—C. B. Atwell, *Northwestern University, Evanston, Ills.*

NOTES AND NEWS.

Mr. E. W. Fisher has been appointed curator of the herbarium of Indiana University.

A dictionary of botanical terms by A. A. Crozier has recently been issued by Henry Holt & Co.

Correction.—In Mr. A. F. Foerste's article in the August Gazette, on p. 244, Hamamelis Canadensis is mentioned twice. This was an oversight, since *H. Virginiana* was intended in both cases.

The following papers by Professor Pammel appear in the Proceedings of the Iowa Academy of Sciences, vol. 1, pt. 2: Woody plants of Western Wisconsin; and, Forest vegetation of the Upper Mississippi.

Dr. H. L. Russell, whose studies of marine bacteria and of the immunity of plants from bacterial diseases are among important recent contributions to bacteriology, has accepted a fellowship in biology in the University of Chicago.

Mr. Walter H. Evans has been appointed by the Department of Agriculture, in the office of Experiment Stations, to have charge of the

compilation of the botanical work of the various Experiment Stations for the "Experiment Station Record."

THE ANATOMY of the stem of Wistaria has been studied by Carlton C. Curtiss, and the results published in the *Journal of the N. Y. Micr. Society* (viii, 79), and again issued as the twenty-eighth Contribution from the herbarium of Columbia College.

YEAST FREE from bacteria, molds, and other impurities, obtained by Hansen's method, has been in use in this country for three years past, according to the *American Brewers' Review*, and is likely to supersede the usual methods of preparation when required in large quantities.

A SYNOPTICAL LIST, with description, of the ferns and fern-allies of Jamaica, is being published by G. S. Jenma, Superintendent of the Botanical Gardens, Demerara, in the *Bulletin of the Botanical Department, Jamaica*. The tenth number appeared in the *Bulletin* for July The list includes many new species.

AN APPRECIATIVE notice of the life and works of Prof. Dr. Emil C. Hansen, of the Carlsberg Laboratory in Copenhagen, with portrait, appears in the *American Brewers' Review* for August 4 and 11. Dr. Hansen has greatly extended the knowledge of fermentation, and made many useful applications of his discoveries.

THE REPORT of the botanical department of the New Jersey Experiment Station for 1891 covers over a hundred pages of the fourth annual report of the Station recently issued. In this report Professor Halsted treats of a large number of fungous diseases of cultivated and wild plants and of the subject of weeds. The report is copiously illustrated.

GARDEN AND FOREST for September 21st, contains the following articles of general botanical interest: "Native shrubs of California," by Professor E. L. Greene (devoted to *Ceanothus*); "The Polemoniaceæ of the Lake Region," by E. J. Hill; and "The self-pollination of the grape," a paper read by Professor S. A. Beach at the Rochester meeting of the American Association.

PROFESSOR J. E. HUMPHREY has resigned his position as "vegetable physiologist" of the Massachusetts Agricultural Experiment Station, the resignation to take effect the first of January. After that time he will spend three or four months in Jamaica in the study of algæ and fungi. He hopes to secure some good developmental material, and to make cultures of Saprolegniaceæ, etc.

THE ENTIRE separate edition of "The Keys to Genera and Species of North American Mosses" reprinted by Prof. Barnes from vol. VIII of the "Transactions of the Wisconsin Academy of Sciences, Arts and Letters," has been disposed of. The pamphlet is therefore "out of print," and can only be obtained by purchasing the volume cited which may be had of the secretary, Dr. William H. Hobbs, Madison, Wis.

PROFESSOR L. H. PAMMEL, of Iowa Agricultural College, has distributed a sixty-page pamphlet containing the following papers: "A lecture on pollination of flowers," delivered at the State Horticultural Society, January, 1892; "Cross and self-fertilization in plants," a paper

read at the meeting of the Eastern Iowa Horticultural Society, December, 1891; and "The effects of cross-fertilization in plants," read at the meeting of the Northern Horticultural Society, December, 1891. The first paper is profusely illustrated.

THE SHRINKAGE of leaves during the process of drying for herbarium specimens has engaged the attention of Mr. E. E. Bogue, who gives measurements before and after drying in *Science* for September 16. From three to five leaves of Quercus coccinea, Arisæma triphyllum, Asimina triloba, Arctium Lappa, Asclepias Cornuti and six other common plants, were examined and found to shrink on an average of one to three-sixteenths of an inch, except the water plant, Nymphaea odorata, which shrank about an inch.

TWO INTERESTING new Uredineæ from South America are described by Dietel (*Hedwigia*, 1892, p. 159). One is a Ravenelia on Acacia, and the other is a Phragmidium on some leguminous plant. The latter merits special attention as it is the only member of the genus not parasitic on the Rosaceæ. It has been imperfectly known for a long time from material collected by Wright in Texas (Saccardo, Sylloge, vii, 749). It is also remarkable for the close agreement in the physical characters of the exospore with Uropyxis Amorphæ.

A LETTER from Prof. L. M. Underwood, delegate from the Botanical Club of the American Association to the International Botanical Congress at Genoa, announces that the attendance was large and representative. Articles I, II and III of the Berlin recommendations were adopted, except that the American suggestion prevails and 1753 was adopted as the uniform date for genera and species. Article IV and other matters were referred to a standing international committee, upon which the American representatives are N. L. Britton, J. M. Coulter and E. L. Greene.

THE FIRST and only circular of the World's Congress Auxiliary relating to botany, which was prepared last May, and should have been mailed from the Chicago office June 1, has been tardily distributed since the September number of the GAZETTE went to press. The chief design of the circular was to obtain the opinion of the botanists of the country upon the feasibility of holding a botanical congress in connection with the Columbian Exposition. The belated appearance of the circular has deprived it of all value, as the botanists at Rochester, acting as a representive body, decided unanimously that a congress under such auspices was not advisable, but that instead one should be held in connection with the meeting of the A. A. A. S. next year in Madison. This will doubtless be done, whatever replies are sent to the circular.

THE CONTRIBUTIONS from the Herbarium of Columbia College are multiplying rapidly. No. 27 is entitled "Note on a collection of Tertiary fossil plants from Potosi, Bolivia," by N. L. Britton. It contains descriptions of some eighteen species, illustrated by three plates. Eleven of the species are new. No. 28 is upon "The anatomy of the stem of *Wistaria Sinensis*," by Carlton C. Curtiss, illustrated by three plates. No. 29 is the sixth bearing the title "New or noteworthy North American phanerogams," by N. L. Britton. Among other notes a new

eastern *Cardamine* is separated from among other forms; the var. *mollis* of *Agrimonia Eupatoria* is raised to specific rank, as is also the var. *Americana* of *Fragaria vesca*; a new *Polemonium* of the North Atlantic states is described and figured; also a new *Phlox* from Montana and Dakota.

AT HIS OWN request Prof. C. R. Barnes has been relieved of revising Gray's "Field, Forest and Garden Botany." The prescribed limitations of space and the ever increasing number of species of cultivated and native plants which it seemed necessary to include proved irreconcilable. His feeling that he could not, under the conditions imposed, make a work satisfactory to himself, led Prof. Barnes to abandon the task. It has now been put into the hands of Prof. L. H. Bailey, whose extensive familiarity with the plants of our fields, forests and gardens will insure a careful and thorough revision. A tentative list of the species to be included, involving a considerable study of the nomenclature of cultivated plants, together with the first draft of the manuscript through Leguminosæ have been placed in Prof. Bailey's hands for such use as he may see fit to make of them.

TWO HUNDRED and forty dollars have been placed at the disposal of the American Microscopical society, to be given as prizes for the encouragement of microscopical research, and Profs. S. H. Gage, of Ithaca, N. Y., D. S. Kellicott, of Columbus, O., and W. H. Seaman, of Washington, D. C., were appointed a committee to prepare the conditions on which they should be granted. The competition will be open to members of the society and to those who make application for membership, before submitting their papers to the committee, which has prescribed the following conditions:

One prize of fifty dollars is offered for the best paper which shall give the results of an original investigation made with the microscope and relating to *plant* life, not less than 3,000 words in length. The methods by which the results were obtained must be given in full. A similar prize for an investigation relating to *animal* life.

Two prizes of twenty-five dollars each will be given for the second best papers on plant and animal life, respectively, on the above conditions.

The papers, drawings and specimens entered for the above prizes are to be submitted to the committee on or before July 1st, 1893, and the papers and drawings will be published in the Proceedings.

One prize of thirty dollars is offered for the best six photomicrographs on some subject in animal or vegetable histology, and another of the same amount for the best collection of six mounted slides illustrating some one biological subject.

There are also two prizes of fifteen dollars each for the second best collection of photomicrographs and slides respectively.

The object of these prizes is to stimulate and encourage original investigation in the biology of North America.

Additional information as to the conditions may be obtained of the committee on prizes.

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Vol. III.—No. 1 will contain a paper by Messrs. John K. Small and A. A. Heller on the Flora of Western North Carolina and contiguous territory.

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